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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
08/801,812	02/14/97	GIVENS J	11675.106

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EATON,K	
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2823	

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MMC2/0308

Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner of Patents and Trademarks

Office Action Summary	Application No.	Applicant(s)	
	08/801,812	GIVENS, JOHN H.	
	Examiner	Art Unit	
	Kurt M. Eaton	2823	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136 (a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *05 December 2000* .

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-28 and 36-63* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-28 and 36-63* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claims _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are objected to by the Examiner.

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. § 119

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. § 119(e).

Attachment(s)

15) ☒ Notice of References Cited (PTO-892)
16) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
17) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 14,15
18) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
19) ☐ Notice of Informal Patent Application (PTO-152)
20) ☐ Other: .

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. Claims 1, 3, 4, 7-14, 16-21, 23, 36-45, and 48-53 are rejected under 35 U.S.C. 103(a) as being unpatentable over Xu et al..

In re claims 1, 16, 23, 36, 38, 45, and 48, Xu et al. (herein referred to as Xu) shows, in an analogous art related to a process for filling contact openings and vias in an insulating layer, in Figures 1-5 forming a recess (14) within a dielectric layer (10) situated on a semiconductor lower substrate (2), wherein the recess extends below a top surface of the dielectric material; forming a diffusion barrier layer (20) on the recess within the dielectric material; forming an electrically conductive layer (30) on the barrier layer, wherein the material from which the diffusion barrier layer is composed has a melting point greater than that of a material from which the electrically conductive layer is composed; forming an energy absorbing layer on the electrically conductive layer, wherein the energy absorbing layer has a greater thermal absorption capacity than that of the electrically conductive layer; applying energy to the energy absorbing layer to cause the electrically conductive layer to flow within the recess, wherein the application of energy to the energy absorbing layer occurs by heating the entire device in a heating chamber maintained at a predetermined pressure; and removing portions of the energy absorbing layer and the electrically conductive layer

that are situated above the top surface of the dielectric material {column 2, line 66 - column 8, line 17}.

Xu does not show wherein a seed layer is formed on the diffusion barrier layer prior to the formation of the electrically conductive layer, wherein the material from which the seed layer is composed has a melting point greater than or equal to that of the material from which the electrically conductive layer is composed; nor wherein the energy applied to energy absorbing layer is applied omnidirectionally.

It would have been obvious to one of ordinary skill in the art at the time the invention was made that the diffusion barrier layer of Xu is composed of material which is found in many seed layers used to adhere the electrically conductive material of Xu to devices. Accordingly, it would have been obvious to one of ordinary skill in the art at the time the invention was made to consider the diffusion barrier layer of Xu as two sequentially deposited layers composed of the same material since separating what was once one layer, into many layers, involves only routine skill in the art. It also would have been obvious that the application of energy to the energy absorbing layer of Xu would have been characterized as being omnidirectional since the energy was applied in a heating chamber and reference to the fact that the entire device of Xu was heated, in addition to the energy absorbing layer, indicates that the energy applied was omnidirectional.

In re claims 3 and 16, Xu shows wherein the material from which the diffusion barrier layer is composed is selected from the group of ceramics, metallics, and intermetallics {column 2, line 66 - column 8, line 17}.

In re claims 4, 17, 23, 41, 42, and 50, Xu shows wherein the material from which the diffusion barrier layer is composed is selected form the group of aluminum nitride, tungsten nitride, titanium nitride, and tantalum nitride {column 2, line 66 - column 8, line 17}.

In re claims 7, 16, and 48, Xu shows wherein the material from which the seed layer is composed is selected from the group of ceramics, metallics, and intermetallics {column 2, line 66 - column 8, line 17}.

In re claims 8, 18, 23, 41, 42, and 51, Xu shows wherein the material from which the seed layer is composed is selected form the group of aluminum, titanium nitride, titanium, and titanium aluminide {column 2, line 66 - column 8, line 17}.

In re claims 9, 19, 23, 39, 40, 41, 42, 48, and 52, Xu shows wherein the material from which the electrically conductive layer is composed is selected form the group of aluminum and copper {column 2, line 66 - column 8, line 17}.

In re claims 10, 20, 23, 39, 40, 41, 42, 48, and 53, Xu shows wherein the energy absorbing layer is composed of a material selected from the group of titanium, titanium nitride, tungsten, tungsten nitride, silicon nitride, silicon dioxide, tantalum, tantalum nitride, and carbon {column 2, line 66 - column 8, line 17}.

In re claims 11, 21, 43, and 48, Xu shows wherein applying energy to the energy absorbing layer utilizes a furnace {column 2, line 66 - column 8, line 17}.

In re claims 12, 16, and 23, Xu shows wherein removing portions of the electrically conductive layer is an abrasive planarization step {column 2, line 66 - column 8, line 17}.

Xu does not show wherein portions of the energy absorbing layer are removed in the abrasive planarization step.

It would have been obvious to one of ordinary skill in the art at the time the invention was made that the energy absorbing layer of Xu would have been removed in the abrasive planarization step used to remove portions of the electrically conductive layer since abrasive planarization

techniques are well known techniques that can remove both energy absorbing layers and electrically conductive layers.

In re claim 13, 16, and 23, Xu shows wherein removing portions of the electrically conductive layer is an chemical mechanical planarizing step {column 2, line 66 - column 8, line 17}.

Xu does not show wherein portions of the energy absorbing layer are removed in the chemical mechanical planarizing step.

It would have been obvious to one of ordinary skill in the art at the time the invention was made that the energy absorbing layer of Xu would have been removed in the chemical mechanical planarizing step used to remove portions of the electrically conductive layer since chemical mechanical planarizing techniques are well known techniques that can remove both energy absorbing layers and electrically conductive layers.

In re claim 14, Xu shows wherein the recess has an aspect ratio greater than about 4 : 1 {column 2, line 66 - column 8, line 17}.

In re claims 16 and 23, Xu shows wherein the recess formed within the dielectric material is formed through a patterning and etching process; and energy absorbing layer is composed of a material having a higher melting point than that of the material from which the electrically conductive layer is composed{column 2, line 66 - column 8, line 17}.

In re claim 37, Xu shows wherein the melting point of the diffusion barrier layer is not less than that of the seed layer and is greater than that of the electrically conductive layer; and wherein the melting point of the seed layer is not less than that of the electrically conductive layer {column 2, line 66 - column 8, line 17}.

In re claim 44, Xu substantially discloses the invention as claimed but fails to show wherein the seed layer includes multiple layers, wherein each layer in the multiple layers is composed of a material selected from the group of silicon and titanium nitride.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to form the seed layer of Xu such that it included multiple layers, wherein each layer in the multiple layers included a material selected from the group of silicon and titanium nitride since dividing a pre-existing seed layer made of a material selected from the group of silicon and titanium nitride into multiple layers involves only routine skill in the art. Furthermore, the specification contains no disclosure of either the critical nature of the claimed seed layer strucutre or any unexpected results arising therefrom. Where patentability is said to be based upon particular chosen seed layer structures or upon another variable recited in a claim, the applicant must show that the particular seed layer structures are critical.

In re claim 49, Xu shows wherein the diffusion barrier layer is upon the top surface of the dielectric material {column 2, line 66 - column 8, line 17}.

3. Claims 2, 5, and 6 are rejected under 35 U.S.C. 103(a) as being unpatentable over Xu as applied to claim 1 above, and further in view of Fiordalice (U.S. Patent No. 5,420,072).

In re claims 2 and 6, Xu substantially discloses the invention as claimed but fails to show wherein the diffusion barrier and the seed layers are formed in a CVD deposition step.

Fiordalice (U.S. Patent No. 5,420,072) teaches wherein diffusion barrier and seed layer materials of Xu may be deposited using CVD techniques {column 2, lines 56-61}.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to deposit the diffusion barrier and seed layers of Xu using CVD techniques since, as evidenced by Fiordalice (U.S. Patent No. 5,420,072), CVD methods are well known methods to

deposit the diffusion barrier and seed layer materials of Xu and the selection of a known deposition process on the basis of its suitability for the intended use involves only routine skill in the art. Furthermore, the specification contains no disclosure of either the critical nature of the claimed deposition method or any unexpected results arising therefrom. Where patentability is said to be based upon particular chosen deposition methods or upon another variable recited in a claim, the applicant must show that the particular deposition methods are critical.

In re claim 5, Xu substantially discloses the invention as claimed but fails to show wherein, prior to forming the seed layer on the diffusion barrier layer, the diffusion barrier layer is heated in an environment substantially containing a nitrogen gas.

Fiordalice (U.S. Patent No. 5,420,072) teaches, when forming a diffusion barrier layer and a seed layer, wherein the diffusion barrier layer and the seed layer are formed of the same material, prior to the formation of the seed layer, the diffusion barrier layer is heated in an environment substantially containing a nitrogen gas {column 2, line 56 - column 3, line 43}.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to form the diffusion barrier layer/seed layer structure of Xu as in Fiordalice (U.S. Patent No. 5,420,072) by, prior to formation of the seed layer, heating the diffusion barrier layer in an environment substantially containing a nitrogen gas since, as evidenced by Fiordalice (U.S. Patent No. 5,420,072) the aforementioned method to form a diffusion barrier layer/seed layer structure is well known in the art and the selection of a known fabrication process on the basis of its suitability for its intended use involves only routine skill in the art.

4. Claims 15, 22, 24-28, 46, 47, 54-63 are rejected under 35 U.S.C. 103(a) as being unpatentable over Xu as applied to claims 1, 3, 4, 7-14, 16-21, 23, 36-45, and 48-53 above, and further in view of Schacham-Diamand.

In re claims 15, 22, 24-28, 46, 47, 54, 57, and 62 Xu as previously applied to any of claims 1, 3, 4, 7-14, 16-21, 23, 36-45, and 48-53 substantially discloses the invention as claimed and additionally shows wherein the semiconductor substrate assembly has a lower substrate defining a plane {see Figure 1}.

Xu thus substantially discloses the invention as claimed but fails to show wherein the recess includes a contact hole situated below a trench, wherein the contact hole terminates at an end thereof at the lower substrate, terminates at an opposite end thereof at the trench, and is oriented substantially perpendicular to the plane of the lower substrate, wherein the trench extends from the opposite end of the contact hole to a top surface of the dielectric material, wherein the trench extends parallel to the plane of the lower substrate.

Schacham-Diamand shows in Figures 16-18 a method for manufacturing an interconnect structure by forming a recess (15/25) within a dielectric material (12a) situated on a semiconductor lower substrate, wherein the recess extends below a top surface of the dielectric material, wherein the recess includes a contact hole situated below a trench, wherein the contact hole terminates at an end thereof at the lower substrate and terminates at an opposite end thereof at the trench, and is oriented substantially perpendicular to the plane of the lower substrate, wherein the trench extends from the opposite end of the contact hole to a top surface of the dielectric material, wherein the trench extends parallel to the plane of the lower substrate {see Figure 16}.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to provide the recess structure of Xu as in Schacham-Diamand since the provision of the aforementioned recess structure into the invention of Xu would have been the result of an obvious type design modification that would have enabled practitioners of Xu to form contacts and interconnects within a single dielectric material in a single step and the selection of a known recess

structure on the basis of its suitability for the intended use involves only routine skill in the art. Furthermore, the specification contains no disclosure of either the critical nature of the claimed recess structure or any unexpected results arising therefrom. Where patentability is said to be based upon particular chosen recess structures or upon another variable recited in a claim, the applicant must show that the particular recess structures are critical.

In re claims 24, 28, and 62, Xu in view of Schacham-Diamand as applied to any of claims 1, 3, 4, 7-14, 16-21, 23, 36-45, and 48-53 substantially discloses the invention as claimed but fails to show wherein the semiconductor lower substrate includes a monocrystalline silicon layer.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to form the semiconductor lower substrate such that it included a monocrystalline silicon layer since monocrystalline silicon is a well known material that is used as semiconductor substrates and the selection of a known material on the basis of its suitability for the intended use involves only routine skill in the art. Furthermore, the specification contains no disclosure of either the critical nature of the claimed material or any unexpected results arising therefrom. Where patentability is said to be based upon particular chosen materials or upon another variable recited in a claim, the applicant must show that the particular materials are critical.

In re claim 25 and 58, Xu as previously applied to any of claims 1, 3, 4, 7-14, 16-21, 23, 36-45, and 48-53 shows wherein the material form which the diffusion barrier layer is composed is selected form the group of aluminum nitride, tungsten nitride, titanium nitride, and tantalum nitride.

In re claim 26 and 59, Xu as previously applied to any of claims 1, 3, 4, 7-14, 16-21, 23, 36-45, and 48-53 shows wherein the material form which the seed layer is composed is selected form the group of aluminum, titanium nitride, titanium, and titanium aluminide.

In re claim 27, Xu as previously applied to any of claims 1, 3, 4, 7-14, 16-21, 23, 36-45, and 48-53 shows wherein the material form which the energy absorbing layer is composed is selected form the group of titanium, titanium nitride, tungsten, tungsten nitride, silicon nitride, silicon dioxide, tantalum, tantalum nitride, and carbon.

In re claim 46, Schacham-Diamand shows wherein the recess includes a first portion having a uniform width and extending within the dielectric material to the top surface of the dielectric material; and a second portion having a height and a uniform width that is less than the width of the first portion and that is not greater than 25% of the height, wherein the second portion extends from the semiconductor substrate to terminate at the first portion {see Figure 16}.

In re claim 47, Schacham-Diamand shows wherein the first portion is a trench having a surface that extends longitudinally parallel to the top surface of the dielectric material, and wherein the second portion is a contact plug {see Figure 16}.

In re claim 55, Xu as previously applied to any of claims 1, 3, 4, 7-14, 16-21, 23, 36-45, and 48-53 shows wherein forming the electrically conductive layer further includes forming a diffusion barrier layer in contact with the lower substrate and the dielectric material; forming a seed layer upon the diffusion barrier layer and composed of a material having a melting point less than that of the material from which the diffusion barrier layer is composed and is selected from a group of ceramics, metallics, and intermetallics; forming conductor layer upon the seed layer; and forming an energy absorbing layer on the conductor layer that is composed of a material having both a higher thermal insulation capacity and electric insulation capacity than that of the material from which the conductor layer is composed; wherein the omnidirectional heating is performed with a furnace.

In re claims 56, Xu as previously applied to any of claims 1, 3, 4, 7-14, 16-21, 23, 36-45, and 48-53 shows wherein the contact hole has a height and a width, wherein the height is greater than four times the width.

In re claim 60, Xu as previously applied to any of claims 1, 3, 4, 7-14, 16-21, 23, 36-45, and 48-53 shows wherein the material from which the electrically conductive layer is substantially composed is selected form the group of aluminum and copper.

In re claims 61 and 63, Xu as previously applied to any of claims 1, 3, 4, 7-14, 16-21, 23, 36-45, and 48-53 shows wherein applying energy to the electrically conductive layer is performed with a furnace.

Response to Arguments

5. Applicant's arguments with respect to claims 1-28 and 36-63 have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

6. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be

calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

7. Paper related to this application may be submitted directly to Art Unit 2823 by facsimile transmission. Papers should be faxed to Art Unit 2823 via the Art Unit 2823 Fax Center located in Crystal Plaza 4, room 4C23. The faxing of such papers must conform with the notice published in the Official Gazette, 1096 OG 30 (15 November 1989). The Art Unit 2823 Fax Center number is **(703) 308-7722** or **–7724**. The Art Unit 2823 Fax Center is to be used only for papers related to Art Unit 2823 applications.

Any inquiry concerning this communication of earlier communication from the examiner should be directed to **Kurt Eaton** at **(703) 305-0383** and between the hours of 8:00 AM to 4:00 PM (Eastern Standard Time) Monday through Friday or by e-mail via kurt.eaton@uspto.gov.

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